

**REPETITIVE HIGH-DENSITY PACKING MECHANISMS FOR
ARRANGING SUSPENDED LENGTHS OF ELONGATED ITEMS IN A
DESIRED ORIENTATION AND ASSOCIATED METHODS**

Related Applications

This application is a divisional of U.S. Application Serial No. 10/171,862, filed June 13, 2002, the contents of which are hereby incorporated by reference as if recited in full herein.

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Field of the Invention

The present invention relates to handling of products within processing facilities and is particularly suitable for loading lengths of products such as elongated extruded or stuffed food products on carriers in food preparation and production systems.

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Background of the Invention

Conventionally, extruded or stuffed food products such as pasta, dough, and meats such as hot dogs, links, or sausages, can be processed so that the desired food material is extruded or mixed and prepared, then propelled through a "stuffer machine" that includes a stuffing nozzle, extrusion machine, or co-extrusion machine.

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In operation, in certain food items, as the food moves through the stuffing nozzle or extrusion head, a natural or synthetic casing is disposed about and/or deposited or wrapped around the external surface of the food material to form a continuous length of encased elongated food product. To form certain products (such as hotdogs and sausages), the casing can be twisted, tied, nipped, and/or crimped at certain intervals,

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forming a chain-like string or strand of encased food product. Extruders and co-extruders are available from various commercial manufacturers including, but not limited to, Townsend Engineering Co., located in Des Moines, Iowa. Stuffers are available from various commercial manufacturers including, but not limited to, HITEC Food Equipment, Inc., located in Elk Grove Village, Illinois, Townsend

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Engineering Co., located in Des Moines, Iowa, Robert Reiser & Co., Inc., located in Canton, MA, and Handtmann, Inc., located in Buffalo Grove, Illinois. Exemplary stuffer and/or linker apparatus are also described in U.S. Patent Nos. 5,788,563;

5,480,346; 5,049,108; and 4,766,645. The contents of these patents are hereby incorporated by reference as if recited in full herein.

After stuffing or extruding, the encased elongated food product is expelled from the stuffer or extruder via a material discharging exit port. **Figure 1A** illustrates a conventional stuffer **10** and stuffer material discharge port **10p**. The stuffer discharge port **10p** is positioned proximate a “linker” or looping and transferring device **15** (**Figure 1B**) that rotates an endless chain of hooks **15h** about the discharge port **10p**. Generally described, the material discharge port **10p** is configured so that, during operation, the product is expelled and directed so that the traveling hooks, which serially travel to be adjacent the discharge port **10p**, catch a portion of the length of the product, with the result that the product forms loops on the hooks at certain intervals. More specifically, certain devices are configured so that the hooks **15h** travel to the discharge port **10p** and the discharge port **10p** discharges into a downwardly inclined channel that directs the elongated food downward and, as the hooks turn to face the discharged food, the hooks sequentially individually reach out to grasp the product at certain intervals. Other devices propel the encased product onto hooks that rotate thereabout (typically under) to catch the product at certain intervals to transfer the encased material onto the transfer device. The hooks **15h** then suspend the product in a looped configuration (hanging in a vertical orientation) as shown in **Figure 1B**, with each hook **15h** supporting a single loop of product.

Figure 1C illustrates a slightly different prior art stuffer **10** and associated linker **15** with hooks that are oriented to rotate in a different plane from that shown in **Figure 1A** (*i.e.*, a vertical plane rather than a horizontal plane). In addition, in this prior art stuffer/linker, the discharge port **10p** terminates into a short expanse of tubing that forms a rotating discharge nozzle **10r**. The rotating nozzle **10r**, again, propels the extruded encased product onto the hooks **15h**.

After the product is suspended on the hooks **15h**, a rod or stick is typically manually inserted through the suspended looped product above the hooks and below the upper looped portion of the food, and the product is manually lifted up and off the hooks **15h** and transferred to a trolley, oven, or other food processing station.

In view of the foregoing, there is a need to provide automated processing systems that can improve the production process to facilitate the loading of food

receiving members such as sticks and/or reduce the need for manual labor to load sticks and/or that can more controllably transfer strands of elongated items in an automated manner.

Summary of the Invention

5 The present invention provides automated winder systems, methods, and devices that can automate the loading of extruded or stuffed product in a desired increased density packing arrangement onto a carrier or transfer support member such as a stick or rod. The automated winders can be configured to remove the need for a hook-based continuous looping system, and/or manual insertion of rods to lift the
10 looped product onto the rods, from the production process. Indeed, in particular embodiments, the automated winder can load the elongated product in a desired packing density directly onto a stick or desired support transfer or carrier member that can then be used to transfer the product to (and/or through) the next processing station (such as a smoker, oven, curer or the like).

15 Certain embodiments of the present invention are directed to methods for loading carrier members with suspended elongated product. The methods can be carried out to wipe, push, or pull adjacent segments of the suspended product closer together to increase the amount or density of the product loaded or held on the carrier member.

20 Certain embodiments are directed to high-density packing mechanisms and methods with a packing arm that extends and retracts repeatedly about a portion of the length of the carrier member thereby sweeping or pushing adjacent segments of suspended product closer together on the carrier member. The carrier member can be moving (forward or rearward) as the packing arm extends and retracts so that the
25 packing arm reaches over different portions of the carrier member at each revolution or cycle of the extend and retract movement. This can allow the packing arm to pack the suspended product in a high-density closely spaced substantially evenly distributed arrangement over a desired length of the carrier member.

 and y-axis directional components. The transfer or carrier member may be
30 configured to (linearly) translate as the winder arm translates (moved either forward or backward toward or away from the stuffer discharge port) so that the automated winder can load, straddle-wrap or loop, the released product starting at one end

portion of the transfer member and terminating at the opposing end portion so that substantially the entire length (or a desired length) of the transfer member is covered with a continuous length of straddled and/or looped product. As one or more segments of the product is held draped or suspended from the carrier or transfer member, a packing mechanism having an extending and retracting arm can extend about the carrier member to direct at least one of the draped segments to move in a desired direction on the carrier member to position adjacent segments of the suspended product closer together. The packing mechanism can repeat this motion a plurality of times as the carrier member linearly moves to serially contact spatially separate portions of the carrier member and different draped segments of the product during the packing or loading operation.

The packing mechanism can be automatically or manually operated. For automated versions, the packing arm can be driven by an electric motor that causes the arm to move continuously in a closed path that serially causes the packing arm to extend in an upstream direction above the carrier member, decline or lower to contact the carrier member and push the adjacent food segment in a forward direction, rise to move above the carrier member, and then return to the extended position above the carrier member, *et seq.*, thereby repeating the cycle.

Certain embodiments of the present invention are directed to methods for loading a carrier member with suspended elongated product, including: (a) straddling suspended elongated product over a carrier member having a width so that portions of the elongated product are serially draped over the carrier member along a desired length thereof, the straddling being carried out so that the draped elongated product defines suspension regions that contact the carrier member intermediate lengths of the elongated product that hang from opposing sides of the carrier member; (b) moving at least one of the suspended regions on the carrier member in a predetermined direction at a first time; then (c) moving another one of the at least one of the suspended regions on the carrier member in the predetermined direction at a second time; and (d) arranging the straddled elongated product so that serially consecutive suspension regions are more closely positioned together on the carrier member based on the first and second moving steps.

Other embodiments of the present invention are directed to automated high-density repetitive packing mechanisms for arranging suspended elongated product on a carrier member. The packing mechanism comprises: (a) an elongated packing arm having an associated length and opposing first and second end portions, wherein, in
5 operation, said first end portion is attached to a fork member that is adapted to periodically contact a portion of a suspended elongated item held on a carrier member; and (b) a drive mechanism attached to the second end portion of the packing arm to repeatedly move the packing arm in a predetermined motion so that the fork member serially moves in a cycle that includes moving in a first longitudinal
10 direction, stalling for a desired interval of time, traveling down a desired vertical distance sufficient to cause the fork member to engage with the carrier member, moving in a second longitudinal direction opposite the first longitudinal direction with the fork member substantially horizontal and parallel to the carrier member, then rising a distance to reside above the carrier member.

15 The system may be arranged so that over a desired time period, the packing mechanism is substantially continuously operated to serially load a plurality of carrier members and/or transfer support members. Further, in certain embodiments, the carrier member or transfer support member is a stick or rod that can be used to support the elongated product at the next active workstation that may be an oven, a
20 smoker, a curer, or other food preparation/processing station.

These and other objects and aspects of the present invention are explained in detail in the specification set forth below.

25 Brief Description of the Drawings

Figure 1A is a perspective view of a prior art extruded food stuffer and associated linker or transferring and looping device.

Figure 1B is an enlarged view of the looping hooks of the device shown in **Figure 1A** showing an elongated extruded encased food product suspended thereon.

30 **Figure 1C** is a perspective view of another prior art stuffer and linker.

Figures 2A-2F are side views of a sequential series of operations used to pack product in close proximity according to embodiments of the present invention.

Figure 3A is an enlarged front view of the end portion of the packing mechanism shown in **Figures 2A-2F** positioned relative to an underlying carrier member according to embodiments of the present invention.

5 **Figure 3B** is an enlarged front view of the end portion shown in **Figure 3A** with the device translated a distance down so as to engage with the carrier member in front of (or behind) a selected region of suspended elongated product according to embodiments of the present invention.

Figure 4 is a side view of the device shown in **Figures 2A-2F** illustrating a more fully loaded carrier member with a plurality of closely spaced suspended regions held on the carrier member according to embodiments of the present invention.

Figure 5A is a side view of a portion of an automated winder according to embodiments of the present invention.

Figure 5B is a schematic illustration of an exemplary motion pattern of the arm of the automated winder of **Figure 5A** according to embodiments of the present invention.

Figure 5C is a side view of a portion of an automated winder similar to that shown in **Figure 5A** illustrating a different winding pattern according to embodiments of the present invention.

20 **Figure 5D** is a schematic illustration of an exemplary motion pattern of the arm of the automated winder of **Figure 5C** according to embodiments of the present invention.

Figure 5E is a side view of a portion of an automated winder similar to that shown in **Figure 5A** and **5C** illustrating yet another different winding pattern according to embodiments of the present invention.

25 **Figure 6A** is a schematic illustration of a portion of the automated winder illustrated in **Figure 5A** showing the winder arm above the loading stick or receiving member.

Figure 6B is a schematic illustration of a portion of the automated winder illustrated in **Figure 5A** showing the winder arm below the loading stick or receiving member.

Figure 6C is a schematic illustration of a portion of the automated winder illustrated in **Figure 5C** showing the winder arm at a first position with respect to the loading stick or receiving member.

Figure 6D is a schematic illustration of a portion of the automated winder
5 illustrated in **Figure 5C** showing the winder arm at a second position with respect to the loading stick or receiving member.

Figure 7 is a partial perspective view of a portion of the winder arm of the winder of **Figure 5A** with the winding mechanism attached above the winder arm according to embodiments of the present invention.

10 **Figure 8A** is a top perspective view of a portion of a winder arm illustrating an enclosed chute or channel according to embodiments of the present invention.

Figure 8B is an end view of the winder arm shown in **Figure 8A**.

Figure 9 is a side view of an automated winder system illustrating the winder attached below the winding arm according to embodiments of the present invention.

15 **Figure 10** is an end view of the winding mechanism shown in **Figure 9**.

Figure 11 is an end view of the winder arm shown in **Figure 9**.

Figure 12A is a perspective view of an alternative embodiment of an automated winder according to the present invention.

Figure 12B is a side perspective view of the device shown in **Figure 12A**.

20 **Figure 12C** is a front schematic view of the device shown in **Figure 12A**.

Figure 12D is a side view of an alternate embodiment of an automated winder according to embodiments of the present invention.

Figure 12E is a side perspective view of the device shown in **Figure 12D**.

25 **Figure 12F** is an enlarged side view of the winder shown in **Figure 12E** with the arm partially cutaway.

Figure 12G is side view of a winding mechanism shown in **Figure 12F**.

Figure 13A is a front view of an example of a stick/rod as employed as a transfer support member suitable for loading with the automated winders of the present invention.

30 **Figure 13B** is a front view of an alternative embodiment of a transfer support member according to the present invention.

Figure 13C is a front view of yet another alternative embodiment of a transfer support member according to the present invention.

Figure 14A is a side view of a discharge portion of the arm illustrating an end guide according to certain embodiments of the present invention.

5 **Figure 14B** is a side perspective view of an alternate configuration of an end guide according to certain embodiments of the present invention.

Figure 15A is a schematic of a winding pattern according to embodiments of the present invention.

10 **Figure 15B** is a schematic of another winding pattern according to embodiments of the present invention.

Figures 16A-16G are schematic front views of illustrations of exemplary winding patterns that may be used to wrap or position product onto a receiving member according to embodiments of the present invention.

15 **Description of Embodiments of the Invention**

The present invention will now be described more fully hereinafter with reference to the accompanying figures, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Like numbers
20 refer to like elements throughout. In the figures, certain layers, components or features may be exaggerated for clarity, and broken lines illustrate optional features or operations unless specified otherwise. In addition, the sequence of operations (or steps) is not limited to the order presented in the claims unless specifically indicated otherwise. Where used, the terms “attached”, “connected”, “contacting”, and the like,
25 can mean directly or indirectly, unless stated otherwise.

In the description of the present invention that follows, certain terms are employed to refer to the positional relationship of certain structures relative to other structures. As used herein, the term “forward” and derivatives thereof refer to the general or primary direction that food travels as it moves inside a food processor from
30 a processing point or region to the next processing point or region; this term is intended to be synonymous with the term “downstream,” which is often used in manufacturing environments to indicate that certain material being acted upon is

farther along in the manufacturing process than other material. Conversely, the terms “rearward” and “upstream” and derivatives thereof refer to the directions opposite, respectively, the forward and downstream directions.

5 The devices and methods of the present invention may be particularly suitable to pack and/or load elongated food items onto a support or carrier member that can be used to transport, carry, or move the elongated food items to the next desired work or processing station. Elongated food items include, but are not limited to, elastic or partially elastic food items such as cheese (*e.g.*, mozzarella strands), dough (such as for incubation), meat sticks or strands, pasta, licorice or other strands of candy, and
10 meat products. Of course, the processing system can be configured to wind or transfer other items. For example, other elongated products include candles, ropes, string, cables, chain, wires, hose, tubing, and the like.

In certain embodiments, the present invention is used to process and/or transfer or load a length of an elongated extruded product held in a casing onto a
15 support member. The casing can be any suitable casing (edible or inedible, natural or synthetic) such as, but not limited to, collagen, cellulose, plastic, elastomeric or polymeric casing. The elongated product can be an elongated meat product. Exemplary meat products include, but are not limited to, strands of meat (that may comprise pepperoni, poultry, and/or beef or other desired meat), processed meat
20 products such as strand(s) or continuous lengths of meat sticks (including whole or partial meat mixtures), sausages, hotdogs, and the like. The term “continuous” is used interchangeably with “contiguous” to mean that the product is connected or joined (directly or indirectly) over its length.

The elongated product can be configured as a continuous length of product
25 having a length of at least about 20-25 feet per strand, and typically at least about 50 feet. In other embodiments, the length of the continuous product may be up to about 150-200 feet, or even longer. The elongated product may be segmented or non-segmented, *i.e.*, a length of chain-like linked items, or a strand or multi-stranded length of non-chain linked product. Other embodiments may load the elongated
30 product in a series of non-looped discrete lengths. The discrete lengths may be any desired length or combinations of lengths, such as, but not limited to, lengths between about 1-20 feet.

The elongated food item may be elastic (at least in tension) so as to allow some stretching without unduly altering or deforming its desired shape and/or cross-section during processing. The elongated food item may be an extruded product that is held in a natural or synthetic casing as noted above. Other embodiments

5 contemplate product that have rigid configurations but are movable link to link, such as chains of material having sufficient rigidity to retain its shape during processing and/or use (such as those objects formed of sufficient thickness or structure to provide a solid, semi-solid, or hollow length of material). The material may be a composite resin, metal, polymer, elastomeric and/or plastic material, combinations of the same,
10 and the like.

In operation, in certain embodiments, the elongated product may have an exterior surface that, during the loading process, exhibits increased friction relative to a finished, cured, or dried configuration. For example, a processed meat mixture that is held in a collagen casing, prior to finishing, can be described as having a relatively
15 gelatinous, sticky external residue that can cause the food to attempt to stick to a support surface.

Figures 2A-2F illustrate a sequence of operations that can be carried out to arrange suspended elongated product on a carrier member **50** according to embodiments of the present invention. As used herein, the term "transfer support
20 member" is used interchangeably with the term "carrier member." As shown in **Figure 2A**, a packing mechanism **175** is cooperably aligned with a carrier member **50** that is, in turn, cooperably aligned with an automated winder **20**. The automated winder **20** includes a winding arm **21** and has an associated winding or motion pattern **21p** that discharges and loads suspended elongated product onto a cooperably aligned
25 carrier member **50** and is discussed in more detail below with reference to **Figures 5 et seq.** The carrier member **50** is loaded with at least one length of elongated product **25**. As shown, the product straddles onto the carrier member **50** so that the product defines suspension regions **121S₁-121S_n**. The straddling can be carried out in different manners to load, suspend, hang, or drape the product **25** onto the carrier
30 member **50**. For example, as shown in **Figure 4**, the straddling is performed so that the product **25** is arranged in a plurality of loops on the carrier member **50**. **Figure 5C** illustrates that the straddling configuration can be a continuous length of non-

looped bights $B_1, B_2 \dots B_n$ having a series of curves while **Figure 5E** shows discrete lengths of products hanging from the carrier member **50**.

In any event, the packing mechanism **175** includes an elongated packing arm **175a** that moves through a repeating motion cycle illustrated by the arrows proximate the packing arm **175a** in **Figures 2A-2F**. The packing arm **175a** includes opposing first and second end portions **175a₁, 175a₂**, respectively. The first end portion **175a₁** can be formed as or include a fork member **176** that, in operation, periodically reaches over and down to contact the outer surface of the carrier member **50** (**Figures 3A, 3B**) and/or a portion of a suspended elongated product **25** held on a carrier member **50** to swi-
pe, move, push, or pull regions of the product **25** in a desired direction on the carrier member **50** to provide a more closely spaced or symmetrical or desired loading/packing arrangement.

As shown in **Figures 2A-2F**, the packing mechanism **175** also includes a drive mechanism **177** attached to the second end portion of the packing arm **175a₂** to repeatedly move the packing arm **175a** through a predetermined motion cycle so that the fork member **176** serially moves through its travel cycle. The drive mechanism may be automatically or manually operated. **Figure 2A** illustrates that the drive mechanism **177** can be operably associated with an automated drive means such as a motor **177m**. As shown by the sequence in **Figures 2A-2F**, the cycle sequence may be such that the fork member **176** moves in a first longitudinal direction (shown in the rearward substantially longitudinal direction in **Figure 2A**), travels down a desired vertical distance sufficient to cause the fork member **176** to engage the carrier member **50** (**Figures 2B, 2C** and **3A, 3B**), moves in a second longitudinal direction opposite the first longitudinal direction with the fork member substantially horizontal (**Figures 2D, 2E**), then rises a distance to reside above the carrier member **50** (**Figure 2F**). The arm **175a** and the fork member **176** may be configured to stall for a desired interval of time during a portion of the cycle, typically after they rise (**Figure 2F**) and before they descend again (**Figure 2B**). The stall or static interval can be timed to define when the fork member **176** will next contact the carrier member **50**. The stall interval can depend on the discharge speed of the product **25** from the winder mechanism **20**, the speed of the winder **20** as it moves through its winding path **21p** and the number of times it is desired for the fork member **176** to contact the carrier

member 50 and/or product 25. For example, in certain embodiments, the winding arm 21a may be configured to operate with a pause of about 0.5-2 seconds at one or more locations in its travel path, as the winding arm 21a (Figure 5A) moves about the carrier member 50. In other embodiments, increased stall times can be used, while in
5 still other embodiments no stall time is used as the amount or speed of drag or movement of the fork member 176 can be timed to continuously move through its operative positions in a variable or constant speed. Combinations of variable speeds, constant speeds, and the use of stall intervals may also be used depending on the application.

10 For example, the carrier member 50 can be loaded by having the winding arm 21a present the product onto the carrier member 50 so that it is straddled in a desired suspended configuration. The straddling operation has an associated speed that is dependent upon the discharge rate of the product 25 from the winder 20 and the speed of movement of the winder arm 21a about the carrier member 50. Similarly, the
15 packing arm 175a also has an associated speed. The packing arm 175a speed can be adjusted based on the speed of the straddling operation so that it does not disrupt the loading and can move the product 25 at desired intervals during the loading cycle.

In operation, in certain embodiments, the straddling operation is carried out by the winding arm 21a as it travels in a predetermined pattern and discharges food 25
20 therefrom in a forward direction while the winding arm 21a is traveling through its pattern 21p. The packing arm 175a can be configured to move rearward and forward in a repetitive packing cycle. That is, the repetitive packing cycle can be performed so that the packing arm 175a serially moves in a rearward direction above the carrier member 50 relative to the direction of the discharged food, then stops for a static
25 interval before it declines to contact the carrier member 50 and moves forward thereby pushing the suspended region in back 176b of the packing arm 175a forward, and then rises to complete a packing cycle.

In certain embodiments, the carrier member 50 can be translated forward during the operation of the packing mechanism 175. In this situation, the fork
30 member 176 can sequentially engage different segments of the product and/or different locations of the carrier member 50 to thereby arrange different portions of the product to be closer together. The carrier member 50 is shown as moving forward

(horizontal arrows proximate the carrier member 50 in **Figures 2B-2F**) with the packing arm 175a also moving or pushing the suspended product forward on the carrier member 50 itself. However, the movement of the arm of the mechanism 175a and translation of the carrier member 50 can be reversed. In addition, in lieu of
5 moving the carrier member 50, the winding arm 21 of the winder 20 and the packing mechanism 175 can be moved with the packing mechanism being stationary to distribute elongated product over a desired length of the carrier member 50.

Further, in certain embodiments, instead of positioning the packing mechanism 175 in front of (downstream of) the winding arm 21 as shown, the
10 packing mechanism 175 may be placed to the side or rear of the winding arm 21 and be configured to reach in and periodically push, pull or move the suspended product forward or rearward on the carrier member 50 (not shown).

Figures 2A and 2B illustrate that the winding mechanism 177 can be mounted to a platform 175p that holds at least a portion of the mechanism 177 thereon. As
15 shown, the platform 175p includes an upper bracket 190 that holds the packing arm 175a in a manner that allows the packing arm 175a to pivot thereon. The platform 175p can also include a lower bracket 191 that can hold an edge portion of the carrier member 50. The lower bracket 191 may be operably associated with a drive track 193 mounted on the platform 175p that automatically positions the carrier member 50 at
20 the packing station and/or moves the carrier member 50 forward at a desired speed during the packing operation. For additional discussion of suitable take-away and loading systems using drive tracks, see co-pending U.S. Provisional Patent Application Serial No. XXXX, filed April 8, 2002, identified by Attorney Docket Number 9281- 4PR, the contents of which are hereby incorporated by reference as if
25 recited in full herein.

As shown in **Figures 2A and 2B**, in certain embodiments, the drive mechanism 177 can be a four-bar linkage mechanism that includes a rotatable wheel 178 that can be mounted to the platform 175p. The wheel 178 can be powered to be automatically driven by a shaft connected to a motor as shown schematically in
30 **Figure 2A**. The wheel 178 can be substantially continuously operated so as to repeat the packing cycle(s) a plurality of times for each carrier member 50 presented to the packing arm 175a. The wheel 178 is connected to a linkage 179 that may travel in a

restrained slot 180 formed in the wheel 178. The linkage 179 is attached to the arm 175a. In operation, as the wheel 178 rotates, the linkage 179 repeatedly follows a defined path (shown by different locations in **Figures 2A-2E** (**Figure 2F** shows the position shown in **Figure 2A**), and pulls the arm 175a through a desired motion
5 output.

Of course, any suitable mechanisms and/or components can be employed, including, but not limited to, cam/follower arrangements, pistons (pneumatic or hydraulic), combinations of differently configured linkages with any of the above as well as other electromechanical configurations that can generate the desired repeated
10 motion.

The packing arm 175a may be configured to directly contact each suspended region 121S₁ through 121S_n (**Figure 4**) or only selected ones of the suspended regions. The packing arm 175a may be operated to move groups of suspended regions in a desired direction on the carrier member 50 or a selected suspended region
15 independently of the others. In certain embodiments, the packing arm 175a repeatedly moves to push serially successive spaced-part suspended regions forward along the carrier member 50. In other embodiments, the packing arm 175a pushes non-serially successive spaced-apart suspended regions forward along the carrier member 50.

The product 25 may be arranged in a looped (**Figure 4, 5A**) or non-looped (**Figure 5C, 5E**) configuration on the carrier member 50 as will be discussed further below. **Figure 4** illustrates that a continuous length of elongated product 25 is suspended with substantially even lengths 25l₁, 25l₂, 25l_n of product on opposing sides of the carrier member 50 over a desired length of the carrier member 50. Other
20 product loading or draping configurations may also be employed.

Figures 3A and 3B illustrate an example of the fork member 176 that is attached to the end portion of the arm 175a. The fork member 176 includes a forward or front surface 176f and a rear surface 176b, and may also include an aperture 176a that is sized and configured to correspond to the width of the carrier member 50. The
30 fork member 176 can be sized so as to rest on the carrier member 50 as it pushes, wipes, and/or moves the product on the carrier member 50. The fork member 176 may directly or indirectly contact the product and/or the carrier member 50. For

example, as shown the fork member 176 can snugly abut the carrier member 50 and push the food in the desired direction. The fork member 176 may be formed of stainless steel or other material suitable for processing the product (such as food). Lubricating coatings may be employed to inhibit friction between the fork member
5 176 and the carrier member 50 and/or product 25. In other embodiments, the fork member 176 may be configured to controllably discharge fluid such as air, water, or other pressure applying means, in a desired orientation to move the product along the carrier member 50 (not shown).

Referring again to **Figures 3A and 3B**, in operation, the fork member 176
10 travels over the carrier member 50 (**Figure 3A**) and then travels down a distance to cooperably engage the carrier member 50 (**Figure 3B**) so as to move the product along the carrier member 50 in a desired direction to promote efficient side-by-side abutting placement or closely spaced alignment between adjacent suspended regions
121S₁, 121S₂, 121S_n, as shown in **Figure 4**.

Turning now to **Figure 5A**, one embodiment of an automated winder 20 is
15 shown. The automated winder 20 includes an elongated arm 21 with first and second opposing end portions 21a, 21b, respectively, and a winding mechanism 30. In this view, the winding mechanism 30 is schematically illustrated by a translation linkage 30L that is attached to the arm 21 in a manner that allows it to repetitively move the
20 arm 21 in a desired translating motion or pattern. At the other end of the translation linkage 30L can be any number of suitable translation generation means as will be appreciated by those of skill in the art. As shown, the arm 21 directs the elongated product 25 onto a desired transport support member 50 (shown as a stick or rod). In operation, a plurality of support members 50 are serially placed in aligned cooperating
25 position with the arm 21 of the winder 20 so that each support member 50 can be successively loaded or wound with looped elongated product 25.

In certain embodiments, the winding mechanism 30 is configured to provide a motion for the arm 21 that includes at least a substantially continuous or repeating motion (open or closed path) as indicated by the solid line arrows positioned
30 proximate the translation linkage 30L. Additionally, the winder mechanism 30 may also be configured to translate in a more complex, multi-directional motion (as indicated by the broken-line arrows shown adjacent the solid-line arrows, the motion

may also be include movement that is directionally in and out of the paper “the Z axis”). Thus, as shown by the dotted line arrows adjacent the solid line arrows, the translation linkage 30L may drive the arm 21 to move in a direction which is a closed path including two different axis of travel, typically including both X and Y axis
5 directional components. The closed path may be shaped in any desired suitable configuration, including, but not limited to, an oval, teardrop, circular, elliptical, hourglass, square, or rectangle, so as, in operation, it causes the elongate product to wrap to the desired configuration. Further the winding mechanism 30 may be programmably configured to alter its winding pattern, winding speed, and the like,
10 depending on certain parameters such as the product being processed and/or the loading configuration desired.

By way of illustration, as shown in **Figure 5B**, the arm 21 can have a maxima position at a first vertical height $21h_1$, two intermediate positions at a second lesser height $21h_2$ (shown with the arm 21 in dotted line below the maxima height), and a
15 minima position $21h_3$ at still a lesser vertical height (shown with arm 21 at yet another lower position at a minima height). The arm 21 is configured to move a sufficient distance above and below the transport member 50 so as to load or loop the elongate product 25 thereon.

Figure 5B illustrates but one embodiment of a rotational motion pattern 21p
20 for the arm 21 in which the arm 21 successively moves through a closed path pattern. In certain embodiments, as shown in this figure, the pattern 21p may be substantially elliptical or oval. In this pattern, the arm 21 travels through the intermediate positions both as it is moved and/or rotated in the closed path in the downward and upward directions. In position, the transport member 50 is located within the perimeter of the
25 enclosed closed travel path defined by the translating arm 21. In certain embodiments, the transfer member 50 can be located so that it is centrally located within the boundary of the movement of the arm. In other embodiments, the transfer member is asymmetrically positioned (such as closed to the top, bottom or one side of the arm movement). The direction of travel is shown as clockwise in **Figure 5B**, but
30 may be configured to be counterclockwise as well.

Figure 5A shows that the first end portion 21a of the arm is positioned a length away from the discharge port 10p of the upstream processing station. As

shown, the upstream processing station can be the extruder 10 (such as the conventional extruders shown in **Figures 1A-1C**) and the second end portion 21b of the arm is positioned proximate to, and in cooperating alignment with, a discharge port 10p of the extruder (or stuffer) 10 or intermediately positioned member such as a chute. That is, the second end portion of the arm 21b is positioned so as to receive the elongated product 25 from the upstream device and the opposing (first) end portion 21a is configured to release the elongated product 25 after the product 25 has traveled a desired distance over the length of the arm 21. Typically, the product 25 will travel a major portion of the length of the arm, and more typically, substantially the entire length of the arm 21 before it is released. The product 25 can be released directly from the first end portion 21a, or a discharge nozzle or other discharge port can be attached to the arm 21 and used to dispense the product 25 therefrom.

In operation, the transfer member 50 can be configured to start at a first position that is toward the upstream end 21b of the arm 21 and during loading is gradually retracted or translated to be closer to the downstream end 21a of the arm 21 all at substantially the same vertical height (as shown by the horizontal arrows adjacent the transport member 50 in **Figure 5A**). This motion distributes looped product over the desired length of the transport member 50. **Figures 6A and 6B** illustrate the winding translation of the arm 21 with respect to the transport member 50. The transport member 50 is located at a first position P_1 and is gradually moved forward to a second position P_2 as the arm 21 winds the product 25 thereon. Thus, the transport member 50 moves a distance ΔP .

In certain embodiments, the transport member 50 moves at a substantially constant speed or increments of travel distance that is synchronized and/or responsive to one or more of the speed of the winding (speed of the arm), the speed of forward movement of the product 25 as it exits the arm 21, and the desired looping arrangement/configuration (length of the loops) on the transport member 50. In certain embodiments, the movement of the transport member 50, the winding speed of the arm 21, and/or the speed of the elongate product 25 as it moves off the arm, can vary to provide variable loading density or looping lengths. Thus, the movement distance and speed of movement of the transport member 50 can vary depending on the desired loading of the transport member and winding speed and loop configuration

(length, etc.). Typically, the transport member 50 moves a distance that corresponds to a substantial portion of its length (*i.e.*, greater than about 51-75% thereof).

Although described as starting from a rearward position and moving forward, the transport member 50 can be configured to move in the reverse direction also.

5 **Figure 5C** illustrates an alternate loading arrangement of the elongated product on the transport or receiving member 50 with an example of an associated winding pattern 21p of the arm 21. As shown, the arm 21 is configured to load the product in a suspended straddled, non-looped configuration (*i.e.*, the product does not double over or loop to cross or close upon itself). As shown in **Figure 5C**, one or
10 more one continuous lengths of released elongated product can be loaded onto the transfer support member 50 in response to the release of the product 25 from the moving arm during the translation thereof so that the elongated product 25 is arranged in a straddled configuration with a plurality of adjacently arranged non-looped vertical lengths, such as L₂, L₄ or L₅, L₇, hanging on the same side of the transfer
15 support member and a plurality of different adjacent non-looped lengths, such as L₁, L₂ or L₄, L₅, hanging on the opposing side of the transfer support member so that the elongated product 25 has a plurality of suspension contact points 121Sn spaced apart about a desired length of the transfer support member 50. As used herein, the term
20 “suspension contact points” means the discrete physical contact spaces, areas, or regions between the product 25 and the transfer support member 50. The area or size of the contact points may vary depending on the size, weight, and/or width of the product, and/or the size and/or width of the transfer support member 50.

Still referring to **Figure 5C**, as shown, the winding mechanism 30 is configured to configure the suspended straddled arrangement of the elongated product
25 25 on the transfer support member 50 such that, in serial order, a first continuous length of product is arranged so that a first vertical length L₁ of the elongated product extends about one side of the transfer support member 50, a second vertical length L₂ extends over the opposing second side of the transfer support member 50 after the first length L₁, a first suspension portion 121S₁ is located intermediate the first and
30 second lengths L₁, L₂, respectively. A third adjacent length L₃ laterally extends along the second side of the transfer support member 50 after the second length L₂, a fourth vertical adjacent length L₄ extends along the second side of the transfer support

member 50 after the third length L_3 , a fifth vertical adjacent length L_5 extends along the first side of the transfer support member 50 after the fourth length L_4 , a second suspension portion 121S₂ is located intermediate the fourth and fifth lengths L_4 , L_5 , respectively, and a sixth adjacent length L_6 laterally extends along the first side of the transfer support member 50 after the fifth length L_5 .

In operation the arm 21 can move have lateral directional travel components so as to move back and forth across above the transfer support member 50. In so doing, the elongated product 25 can be discharged to hang or drape from a first side of the transfer support member 50, cross over the width of the body of the member 50 and hang or drape another vertical segment down the other opposing second side. The arm 21 continues to release the elongated food so that another vertical segment or portion hangs or drapes still on the same second side before it re-crosses over the transfer support member 50 and drapes another vertical length back on the first side of the transfer support member. The non-looped straddled product can be arranged so that the suspended vertical draped lengths are substantially the same, dissimilar, or combinations thereof. The draping motion can be continued so as to substantially fill a major portion or substantially all of the length of the transfer support member with the elongated product 25. The lateral lengths of product (*i.e.*, L_3 , L_6) can be disposed so that they are substantially horizontal as shown, or in other desired configurations. The length of the lateral segments can alter and can be controlled by the movement pattern and speed of discharge, the speed of the motion of the arm, and the movement and speed of the transfer support member 50 during the loading process or operation.

Figure 5E illustrates that in lieu of a single continuous length of product 25, a plurality of discrete product lengths can be straddle loaded onto the transfer support member 50. In operation, the winding mechanism 30 causes the arm 21 to release a plurality of discrete lengths of elongated item 25 so that the items are arranged in a suspended laterally spaced apart straddled configuration, each discrete length having opposing first and second end portions 25p₁, 25p₂ and an intermediate portion 121S₁, 121S₂, therebetween, respectively. In position, the first and second end portions 25p₁, 25p₂, respectively, vertically extend to reside adjacent to each other on opposing sides of the transfer support member 50 and the respective intermediate portion 121S₁ or

121S₂, defines a respective one suspension contact region that contacts the transfer support member 50.

Referring to **Figure 5C**, stated differently, certain embodiments of the suspended straddle configuration of elongated product 25 on the transfer support or carrier member 50 is provided so that sections of the elongated product form bights B₁, B₂... B_n that are draped from the rod, with longitudinally consecutive or serially positioned bights, being formed and/or located on opposing sides of the carrier member. The bights are sections of the elongated product that bend or curve but do not intersect. As such, the elongated product has adjacent or serially consecutive bights, each of which can have a series of bends or curves (*i.e.*, defined by serially consecutive vertical, longitudinal, and vertical segments) that are draped on one side of the carrier member 50 before the next bight starts across the other side of the carrier member 50. The loaded transfer member 50 can define a loaded carrier member assembly with elongated product thereon. The product can be arranged on the carrier member so that the elongate product is suspended in a straddled configuration, draped from the carrier member, so that sections of the elongated product form bights, with serially consecutive bights being formed on opposite sides of the carrier member. Each or selected bights can have a plurality of bends or curves and the adjacent bights do not intersect or crossover each other.

Figure 5D illustrates an exemplary loading motion 21p of the arm 21 that can be used to provide the straddle arrangement shown in either **Figure 5C** or **5E**. As shown, the loading motion is an open path that has a boundary that has lateral components that permits the arm 21 to travel back and forth across the width of the transfer support member 50. As shown, the arm 21 is disposed so that the travel path boundary primarily extends above the underlying transfer support member 50.

Figure 5D also shows that the travel motion 21p can be substantially arcuate with the shape defined by lowermost points 21p₁, 21p₃, and the maxima position 21p₂. In operation, the arm 21 can repetitively travel in the motion pattern shown 21p or in other suitable motion patterns. **Figures 16A-16G** illustrate exemplary straddle loading motion patterns 21p, some of which are open and some of which are closed travel paths.

Figures 16A, 16C, 16D, and 16E illustrate different open arcuate patterns 21p. Figure 16A illustrates that the arcuate pattern 21p can be reversed so that it turns upward with opposing end portions 21p₁, 21p₂, that are above the transfer support member 50 and a minima location 21m disposed therebetween. Figures 16G and 16F illustrate closed path motion patterns 21p for the arm 21. The pattern 21p shown in Figure 16G is above the rod and has increased vertical travel distance relative to the amount of lateral travel distance. Figure 16F illustrates that the path 21p may have increased horizontal or lateral travel distance relative to the amount of vertical travel distance. Figure 16F illustrates that in certain embodiments, no matter whether an open or closed path, and notwithstanding the configuration thereof, the travel motion pattern 21p can be offset, inclined about, and/or not centered on or over the transfer support member 50.

Figures 6C and 6D illustrate the translation of the arm 21 with respect to the transport member 50 (each moving during the loading operation) that can be used to straddle load the transport member 50 with product 25 such as shown in Figures 6C and/or 6E. The transport member 50 is located at a first position P₁ and is gradually moved forward, typically in a unidirectional manner, to a second position P₂ as the arm 21 drapes or hangs the product 25 thereon. Thus, in the portion of the loading cycle illustrated, the transport member 50 moves a distance ΔP. The travel path of the transport member can be such that it is generally below and different from that of the arm 21. In certain embodiments, the arm 21 travels side to side over the transport member with a constant or variable speed while the transport member 50 moves unidirectionally forward at a desired speed.

The length of the arm 21 can vary depending on various factors, such as, but not limited to, the size of the product, the forward speed of the product, the desired winding pattern and the like. In certain embodiments, the length of the arm 21 is sized to be at least the length of the transport member 50. In other embodiments, the length of the arm 21 is such that the elongate product 25 travels at least about 2-8 feet, and typically at least about 6 feet, before being discharged therefrom onto the support member 50.

The automated winder 20 may be configured to be self-supporting or free-standing and portable or free-standing and secured to the production floor relative to

the related upstream and/or downstream equipment, as desired. In other embodiments, the second end portion **21b** of the arm can be attached to the extruder or upstream device **10** so as to be in communication with the discharge port **10p**. As such, the second end portion **21b** is stationary but can be pivotally attached to the device **10**. In certain embodiments, the second end portion **21b** is mounted so as to be able to move bi-directionally; the mounting or attachment can be configured in any suitable manner, such as, but not limited to, a universal joint, ball joint, bearing, elastomeric joint, and the like. **Figure 11** illustrates an end view of one embodiment of the arm **21** with an end portion **21b** configured to be mounted to an extruder or other upstream-positioned device. As shown, the end portion **21b** is configured to be affixed to a device **10** so that it is stationary or fixed in place but allowed to translate in a bi-directional manner in response to forces introduced by the movement of the arm **21** as it, in turn moves in response to forces introduced by the winding mechanism **30** (**Figure 9**).

The arm **21** can be any desired shape or configuration. The arm **21** includes a floor **21f** that supports the elongate product **25**. The floor **21f** can be stationary or moving, or combinations thereof. For example, the floor **21f** can comprise rollers, low-friction coatings or surfaces, a conveyor belt(s), and the like. In certain embodiments, the floor **21f** is defined by an endless conveyor **23** (**Figure 9**) that wraps around the arm **21** to continuously convey the product **25** forward and then return to the starting position by traveling back underneath the floor **21f**. As shown in **Figure 8B**, the arm **21** can include a channel or chute **21ch** that is configured with a shape that complements the elongated product **25**. For example, for a substantially circular cross-section product **25**, the floor **21f** may include an arcuate or semi-circular channel **21ch** formed into the floor that is configured to receive a portion of the perimeter of the body of the product therein. In certain embodiments, the channel **21ch** may be sized to be slightly larger, *i.e.*, have a sectional height and/or width that is about 0.1-10% greater, than the height and/or width of the product **25**. The channel **21ch** may be formed over all or portions of the length thereof. The elongate product **25** can be held in the channel **21ch** as it travels over the length of the arm **21**.

As shown in **Figures 8A** and **8B**, the arm **21** may include a cover member **21c** that covers the floor **21f** and encloses the elongate product **25** therein. In certain

embodiments, the channel 21ch and the cover 21c may be formed from two or more matable shell members or, alternatively from a housing or a conduit that is positioned on the arm 21 to define an enclosed channel 21ch. The cover 21c may be transparent or translucent or include viewing windows along the length thereof so that a machine or operator may view or inspect product flow at desired points (or substantially all or all of the travel path). The cover 21c may be formed of a solid material. In other

5 embodiments, a permeable or mesh-like cover (not shown) can be used.

Various automated detectors can be placed at desired locations along the arm to verify proper operation and to render an alert when an abnormality is indicated.

10 Examples of such detectors include optical detectors (infrared or otherwise that respond to changes in visual intensity or generated light beams), flow meters, pressure meters, temperature sensors, and the like.

As shown in Figure 5A, the winding mechanism 30 is configured to approach the arm 21 from the lower or bottom surface. As such, the winding mechanism 30 can be attached, directly or indirectly, to one or more of the bottom side (lower

15 primary surface) and/or one or more sides (minor surfaces) of the arm 21. Figure 7 illustrates that the winding mechanism 30' may alternatively be mounted to approach the arm from the topside. As such, the winding mechanism 30' can be configured to suspend the arm 21 and may be attached, directly or indirectly, at the upper primary

20 surface and/or one or more sides of the arm 21. Still other embodiments can be configured so that the winding mechanism 30, 30' is attached via one or more end portions 21a, 21b, of the arm (not shown). Combinations of the attachment configurations noted above may also be used.

Referring to Figures 5A, 5B, and 9, the winding mechanism 30 may be attached at an intermediate position at one or more attachment locations, the attachment locations being a distance away from each of the first and second end

25 portions 21a, 21b. Although the winding mechanism may be attached to the arm 21 at any desired length from the respective end portions 21a, 21b, in particular embodiments, the winding mechanism 30 is attached at a primary pivot location that is located inward of the ends of the arm, typically at a location that is inward at least

30 about 20% of the length of the arm (away from each of the ends of the arm). The term "primary pivot location" describes the location on the arm 21 at which the

winding mechanism drives the repetitive motion of the arm. It can be a single point contact, a plurality of points, or a region or regions, depending on the configuration of the winding mechanism itself. The attachment position/configuration, the length of the arm, and the weight of the arm and product may influence the amount of physical
5 movement needed by the winding mechanism 30 to generate the desired translation at the end portion 21a of the arm.

Figure 9 illustrates one embodiment in which the winding mechanism 30 is attached at a primary pivot location 30p that is approximately centrally located between each of the opposing ends of the arm 21. That is, it is located to be within
10 about 10% of the middle location of the arm 21. In certain embodiments, as shown, the arm 21 may also include an initial enclosed entry port 221 (Figure 11) that is configured to direct the elongated product to travel in its desired substantially linear travel path over the arm 21. Similarly, the arm 21 may include an exit block member
15 222 that inhibits through passage of the elongated product 25 thereby facilitating the sideward (discharge) of the elongate product 25. In other embodiments, the pivot or winding mechanism 30 can be located closer to the discharge port, *i.e.*, proximate to or adjacent the product inlet port 21b, this position may allow the arm 21 to be shortened (not shown).

Referring to Figure 10, an exemplary embodiment of a winding mechanism
20 30 is shown. This figure is a side view of the device shown in Figure 9. In this embodiment, the winding mechanism 30 comprises a four-bar linkage 33 that is mounted on a stationary mount bracket 34. The four bar-linkage 33 includes a pivotably mounted rotating link 36, and a stationary mounted wheel 38, a center linkage 30L that is pivotably attached to both the pivotably mounted link 36 and the
25 stationary mounted link 38. In operation, the link 36 and the center link 30L define a minor axis of motion control 40 while the wheel link 38 and the center link 30L define a major axis of motion control 41. The center linkage 30L can include upwardly extending threads 39 that can be used to attach the winding mechanism (directly or indirectly) to the arm 21.

30 The wheel 38 can be driven by a gear or shaft (not shown) to automatically turn the wheel 38 at a desired speed (constant and/or variable). Generally described, as the wheel 38 turns, the center link 30L follows the rotation of the wheel 38, making

the center link 30L move both laterally (indicated by the side-to-side arrows in the upper portion of the linkage) and vertically (indicated by the vertical arrows) all the while limited by the pivotably attached link 36 that limits the lateral motion of the center linkage 30L. In this way, the winding mechanism 30 causes the arm 21 to travel through a repetitive substantially elliptical pattern 21p as shown in Figure 9. Of course any suitable winding mechanism can be employed, including, but not limited to, cam/follower arrangements, pistons (pneumatic or hydraulic), combinations of linkages and any of the above as well as other electromechanical configurations that can generate the desired repeated winding motion.

Figures 12A-12C illustrate another embodiment of a winder 20'. As shown, the arm 21 has two spaced apart floor support mounting brackets 121, 122, a first one 121 positioned proximate the second end portion 21b of the arm and another second one 122 positioned upstream of the first one 121. The first mounting bracket 121 has a junction member 125 that is pivotably mounted to two upwardly extending arms 121₁, 121₂. The junction member 125 supports the arm 21 while cooperating with the winding mechanism 30 so that it allows the arm 21 to move in a multidirectional manner in response to movement of the arm as driven by the winding mechanism 30.

Figure 12C shows that the winding mechanism 30' is attached to the arm 21 at a primary pivot region 30p that is upstream of the first floor support mounting bracket 121. The primary pivot region 30p is at the attachment position of the winding mechanism linkage 130L to the arm. As shown in Figure 12C, the linkage 30L includes a fork-like upper portion 130u that spans the width of the arm 21 and attaches to opposing sides thereof. Similar to the embodiment shown in Figure 10, the winding mechanism 30' shown in Figures 12A-12D causes the arm to move in a substantially elliptical rotational movement pattern. In this embodiment, the winding mechanism 30' includes a vertically elongate linkage 130L (such as a piston or rod) that slidably moves through linkage 136 proximate the upper portion of the vertically elongate linkage 130L and that is connected at the lower portion thereof to a rotational member 138. As shown by the arrows located adjacent the lower rotational member 138 in Figure 12D, in operation, the clockwise rotation of member 138 forces the vertically elongate linkage 130L to move forward and downward and then rearward and upward relative to the arm 21. A counterclockwise arrangement may

also be used. The movement of the vertically elongate linkage 130L is further limited or shaped by the movement of the upper linkage 136 that pivots side to side with respect to the arm 21 (indicated by the arcuate arrows proximate the upper link 136) as the linkage 130L slides through the block 136b that cooperates with the upper link 136. The upper link 136 is pivotably mounted to a block 136b and is mounted to the platform 122 via stationary mounting bracket 34. A spring 130s can be mounted to the platform 122 to help control and/or dampen the movement of the winding mechanism 30' and/or linkage 130L. As the linkage 130L is rotated by the lower linkage 138 it slides upwardly and downwardly through the linkage 136b that in response pivots in lateral direction relative to the arm 21 to cause the repetitive rotation cycle.

Figures 12D-12G illustrate an additional embodiment of the winding mechanism 20''. This embodiment illustrates both a different floor or arm configuration (two overlying conveyors with an intermediate food travel path), and a variation on the winding mechanism linkage assembly. Referring to Figure 12G, an outer perimeter portion of the rotatable link 138 is shown attached to the lower portion of the link 130L. As the link 138 rotates, the elongated link 130L is directed to travel in a multidirectional motion (up and down and sideways). In operation, the rotatable link 138 is substantially constantly rotated or driven by an electric motor. One suitable motor is a ¼ HP 480V three-phase motor having about a 1750 rpm output with a 2.2 ratio.

In addition, as shown in Figures 12F and 12G, the upper link 136 can be (pivotably) attached to the block 136b the link 136 can be (pivotably) attached to the platform 122 via a stationary mounting bracket 34. The spring 130s can be attached to the lower portion of the linkage 130L (proximate the connection to the rotatable link 138) on one end portion and the platform 122 (or bracket 34) at a location proximate the upper link 136 at the other end portion to help control/dampen and/or stabilize the motion generated by the winding mechanism 30''.

Figures 12D and 12E illustrate an arm configuration that can employ two overlying aligned and vertically spaced apart surfaces that define a roof or ceiling 21r and a corresponding floor 21f. In certain embodiments, the roof 21r and/or floor 21f may be formed from one or more conveyors (shown as two spaced apart endless

conveyors) 23u, 23l. The lower conveyor 23l defines the floor 21f for food or other item over the arm travel path. The two surfaces 21r, 21f that may be defined by conveyors 23u (roof), 23l (floor) can be spaced sufficiently apart so as to define a gap therebetween 23g. The gap 23g can be sized so as to allow both conveyor primary surfaces (those facing each other) to contact the food in opposing locations in a manner that does not deform the shape of the food as it travels between the two surfaces 21f, 21r and/or conveyors 23u, 23l, but sufficiently close so as to help guide the food in the travel direction. In other embodiments, the gap 23g may be such that the roof, ceiling, or upper conveyor resides a distance above the food. The two conveyors 23u, 23l may be configured to move at the same speed. In certain embodiments, the speed of the conveyors may be operated between about 2-10 ft/sec, and in particular embodiments, at about 6.5 ft/sec linear movement. The conveyors 23u, 23l may be set to vary speed during operation and may be in communication with a variable speed or frequency controller from AC Tech. The drive motor may be configured similar to that described above for the winder mechanism 30. Although described as two endless conveyors, other configurations can also be used. For example, the floor 21f and/or roof 21r can be formed from more than one conveyor. In other embodiments, the roof can be comprised from 2 or more conveyors creating a channel configuration having a triangle or other multi-sided configuration. The floor can also comprise a plurality of conveyors also defining a multi-sided shape (such as a triangle, open square, hexagon, and the like). In addition, portions of the floor and/or ceiling may be configured as stationary components. Combinations of the above may also be used.

In other embodiments, the floor 21f of the arm 21 can be configured as a "V" or "U" shape (using a conveyor surface formed in that configuration or a plurality of conveyors spaced and oriented to define the desired shape) (not shown) to help hold the food therein as it travels along the arm. Combinations of the above may also be used.

Figures 13A-13C illustrate examples of particular embodiments of transfer support members 50. As shown in Figure 13A, the food transport member 50 may be configured as rod or "stick" 50r. Figure 13B illustrates that the food transport member 50' may be configured as a pair of separate rods or sticks 50r1, 50r2, that are

vertically spaced apart and aligned. The two rods **50r1**, **50r2** may be optionally attached as shown by the broken line **50att** feature in **Figure 13B**. In this embodiment, the winder arm **21** can be configured to travel through a winding path that has a sufficient vertical distance so as to encompass or encircle both of the rods **50r1**, **50r2**. **Figure 13C** illustrates that the transport member **50'''** can include a contiguous body or a shape or configuration that extends below the upper portion as there is no longer any requirement that the transport member be inserted into hooks to remove the suspended product therefrom. The contiguous body may be solid, perforated, forminated, or configured to reduce weight. Similarly, the transport member **50** may include one or more handles **50h** or other externally accessible handling means disposed along the length and/or at selected end portions thereof to promote ease of handling to transport the loaded member to another active station. It will be appreciated by those of skill in the art that the present invention now allows a number of different configurations that that can act as suitable support members **50**, **50'**, **50''** and the present invention is not limited to the embodiments described herein. In addition, in operation, a plurality of transfer support members, of the same or different configurations, may be sequentially (manually or automated) serially loaded and removed by aligning them with the winder **20**.

Figure 14A illustrates that the distal end portion **21a** of the arm **21** can be configured with an end guide **322** that helps to direct the movement of the food as it exits off the arm **21** during the winding operation as the arm moves in its desired winding motion pattern. In operation, the elongated item **25** (shown in broken line) travels through an aperture **322a** defined by the end guide **322**. The guide **322** may have an outer perimeter that is looped and defines a tongue **322t** with an open center. **Figure 14B** illustrates an alternate embodiment of an end guide **322'**. The guide **322'** includes an inwardly oriented tongue **322t'** that defines the aperture **322a'** and spaced apart prongs **322p₁**, **322p₂**. In this embodiment, in operation, the food **25** travels outwardly over the perimeter innermost portion of the tongue **322t**. Other configurations of guides **322**, **322'** may also be used. The end guide **322**, **322'** is illustrated with the arm configuration that employs a ceiling or roof and floor **21f**, **21r**; however, the end guide **322**, **322'** is not limited thereto and may be used with any desired arm configuration. In certain embodiments, the end guide **322**, **322'** may

be positioned proximate to and substantially vertically aligned with the floor 21f. In other embodiments, the end guide 322, 322' may be configured to extend outwardly at a vertical level that is below the floor 21f. In yet other embodiments, the end guide 322, 322' may be configured to rise above the floor 21f.

5 **Figures 15A and 15B** illustrate exemplary winding motion patterns 21p, 21p' contemplated by certain embodiments of the instant invention. **Figure 15A** illustrates a pattern 21p that is substantially constant over the winding of the length of the loading member 50 and that the arm 21 can be held substantially planar (horizontal) as it moves through the winding motion. **Figure 15B** illustrates that a variable winding motion pattern 21p' can be generated. As shown, the winding pattern 21p' increases or amplifies from left to right to have greater minima and maxima height 21h₁, 21h₃ at various positions along the loading member (or between different loading members or products and/or can increase from left to right). **Figure 15B** also illustrates that the arm 21 may be inclined during the winding operation (the arm can also be declined or operated at various times to be a combination of inclined, declined, or level. In addition, the winding pattern 21p, 21p' can vary in other manners (shape or pattern) along the length of winding a particular loading member 50 or vary for each or selected loading members or products.

20 The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the claims.

25 In the claims, means-plus-function clauses, where used, are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures. Therefore, it is to be understood that the foregoing is illustrative of the present invention and is not to be construed as limited to the specific embodiments disclosed, and that modifications to the disclosed

30 embodiments, as well as other embodiments, are intended to be included within the scope of the appended claims. The invention is defined by the following claims, with equivalents of the claims to be included therein.